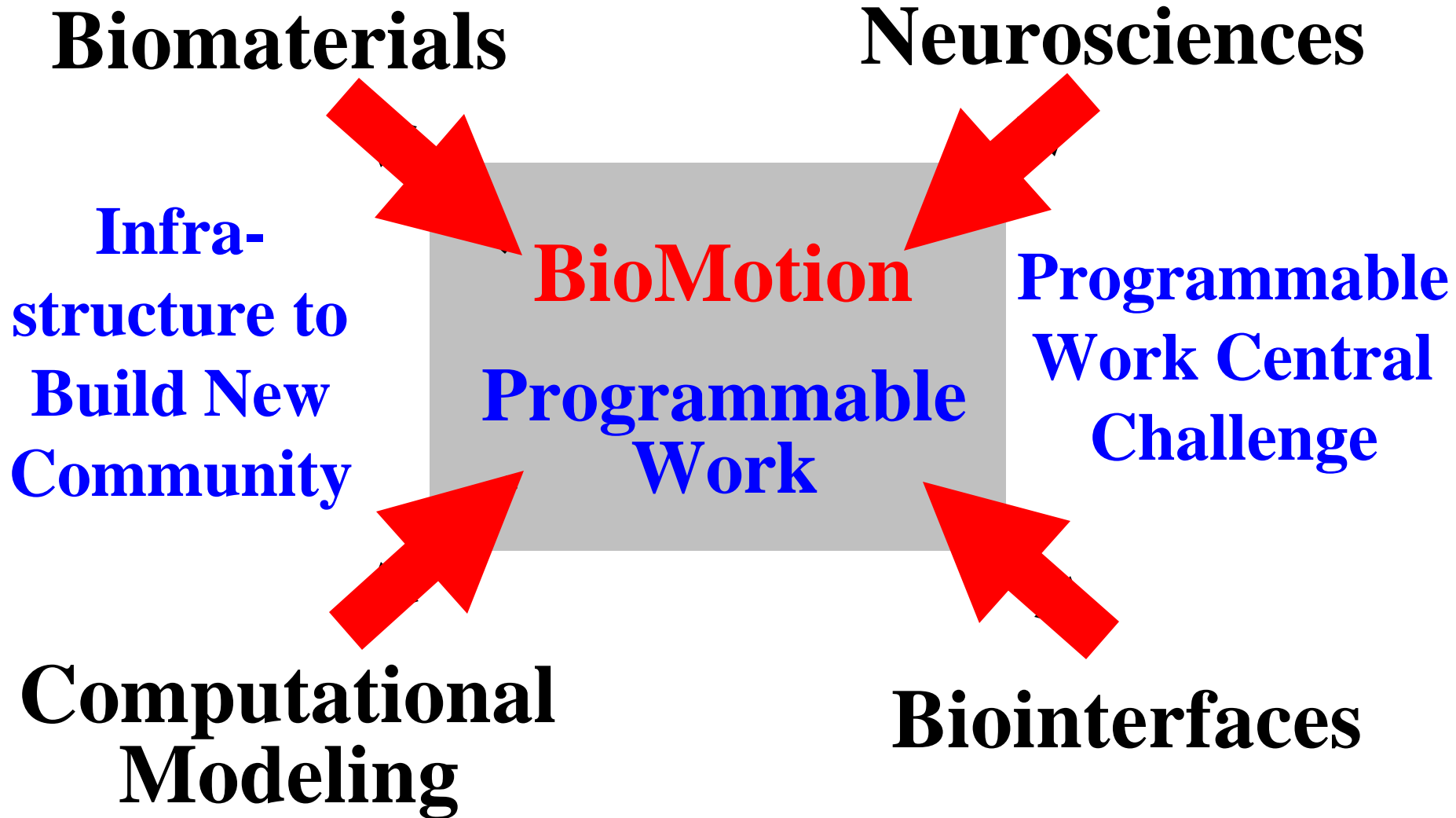# *Focus 2000*

Biology on the Move

Chairs **Robert Full UC Berkeley**

Alan Rudolph DARPA

1. What are critical technical barriers, enablers and opportunities for opening the vista of technological applications?

2. What are the potential technological advancements over the temporal horizon (3-15 years)

3. What are the Defense relevant implications of success?

Age of Integration

Biomaterials

Neurosciences

Infra-structure to Build New Community

BioMotion

Programmable Work

Programmable Work Central Challenge

Computational Modeling

Biointerfaces

BioMotion Vision

1. Control and program motion

2. Move in any environment

3. Manipulate any object

Biomechanical Intersection

Topic: **Biology on the Move, From Molecules to Organisms.**

Areas of Interest: biolocomotion (walking, running, flying, swimming), group movements (flocks, schools) structural and functional appendages (legs, feet, wings, setae, cilia, flagellae), neuromechanics, integration of mechanics and materials, biological motors, force dynamics (hydrodynamics, aerodynamics)

Actuators and integration
2:30 Montemagno, Carlo D. ATP and nanodevices.
        Cornell University

2:50 Daniel, T.L.
        University of Washington

3:10 Lieber, R.
        University of California, San Diego

Computational neurobiology
3:30 Miller. J.
        Montana State University

3:30 – 3:40 BREAK

Flight and neural control
3:40 Dickinson, M.
        UC Berkeley
Swimming
4:00 Lauder. G.
        Harvard University

Running and flying
4:20 Biewener. A.
        Harvard University.

Interface with engineering
4:40 Koditschek, D.
        University of Michigan

Focus Open Discussion Alan Rudolph
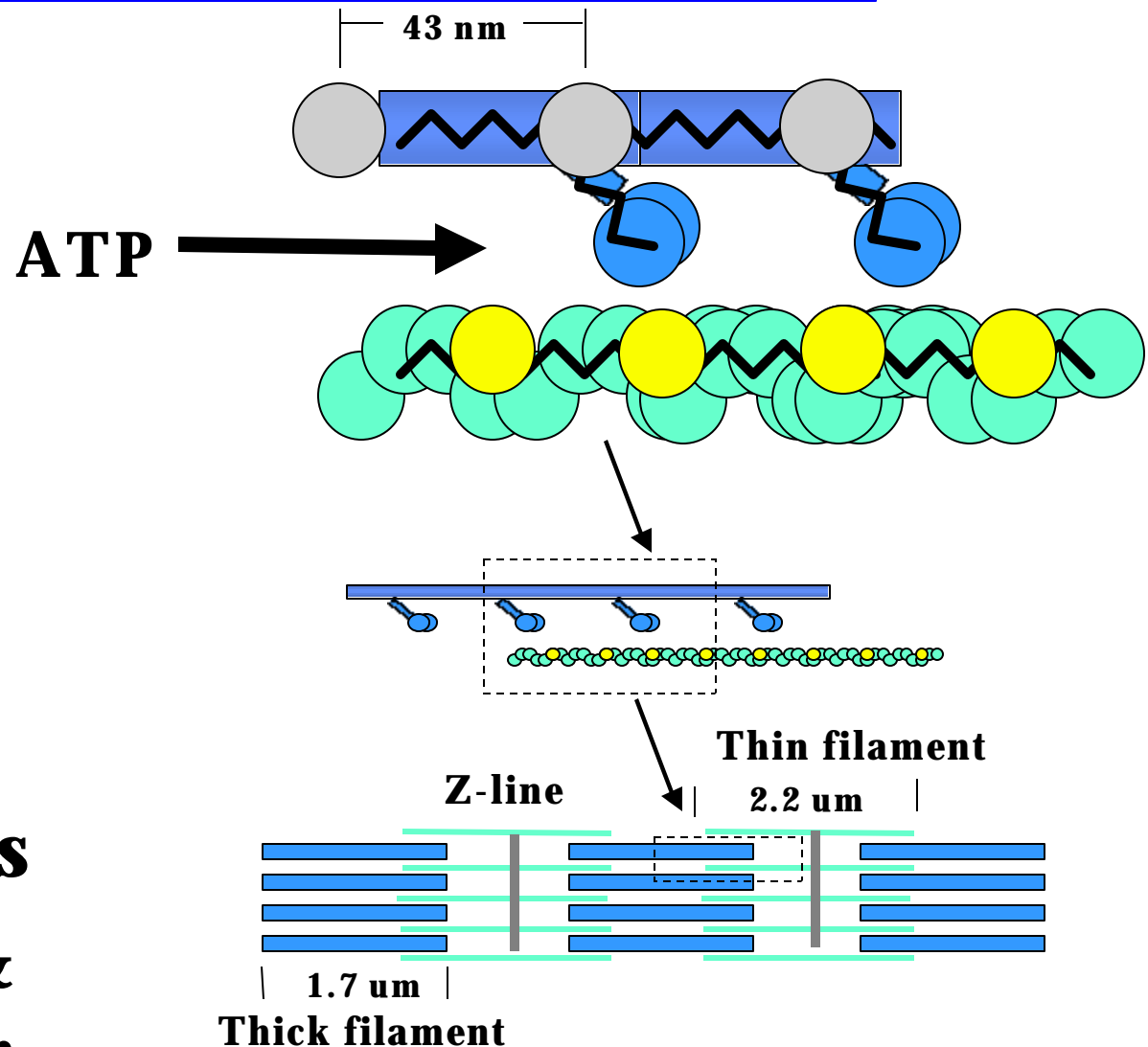5:00 Full, R. UC Berkeley

Integration of Molecules to Muscles

Montemagno
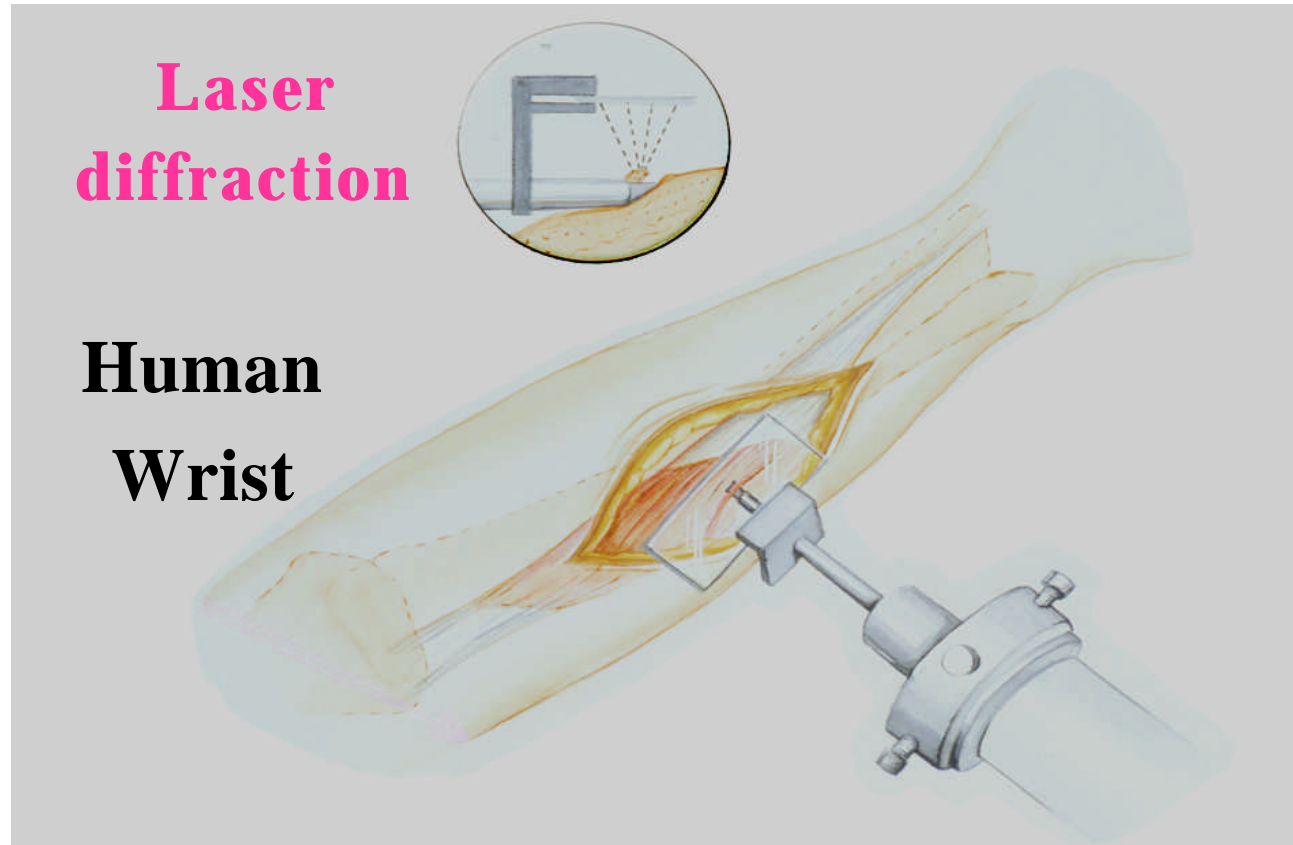*Cornell*
BioEnergy & Nanodevices

Daniel
UW
BioFilaments Properties & System Behavior

43 nm

ATP

Thin filament

Z-line

2.2 um

1.7 um

Thick filament

Integration of Muscles with Joints

Lieber

UC San Diego

Tuned mechanical system

Laser diffraction

Human Wrist

Directly Measure Intrinsic Musculo-skeletal Properties

Encoding Information & Control

Miller

Montana State

Ensemble Neural Encoding

Dickinson

UC Berkeley

Neuromechanical Integration

visual processing

olfaction

central processing

mechanosensory feedback
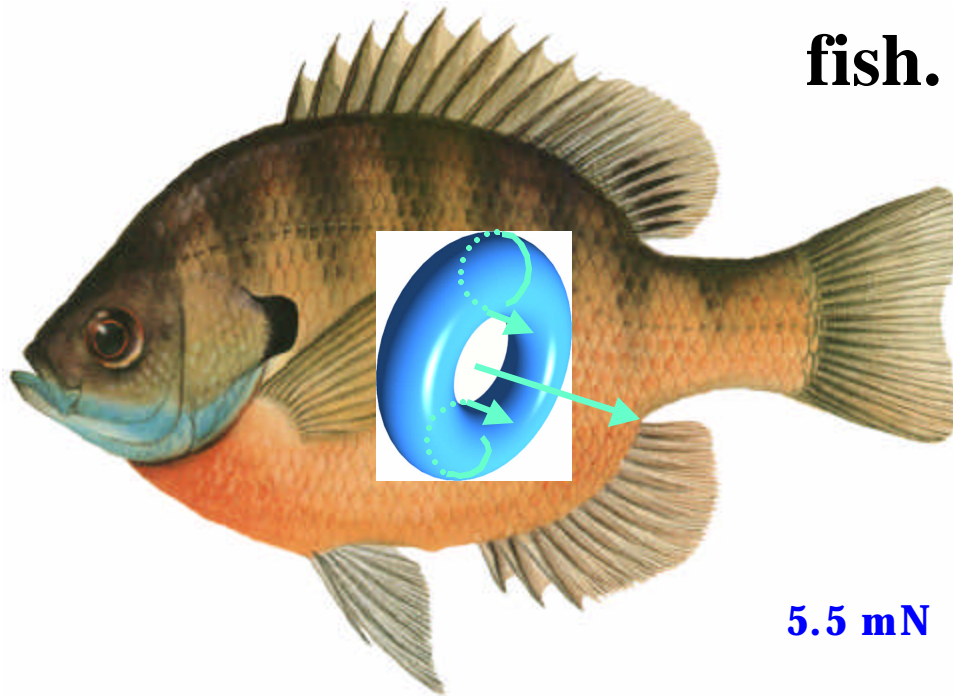
aerodynamics

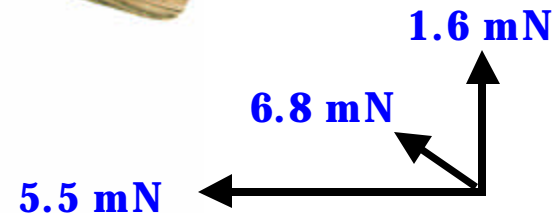muscle&skeleton mechanics
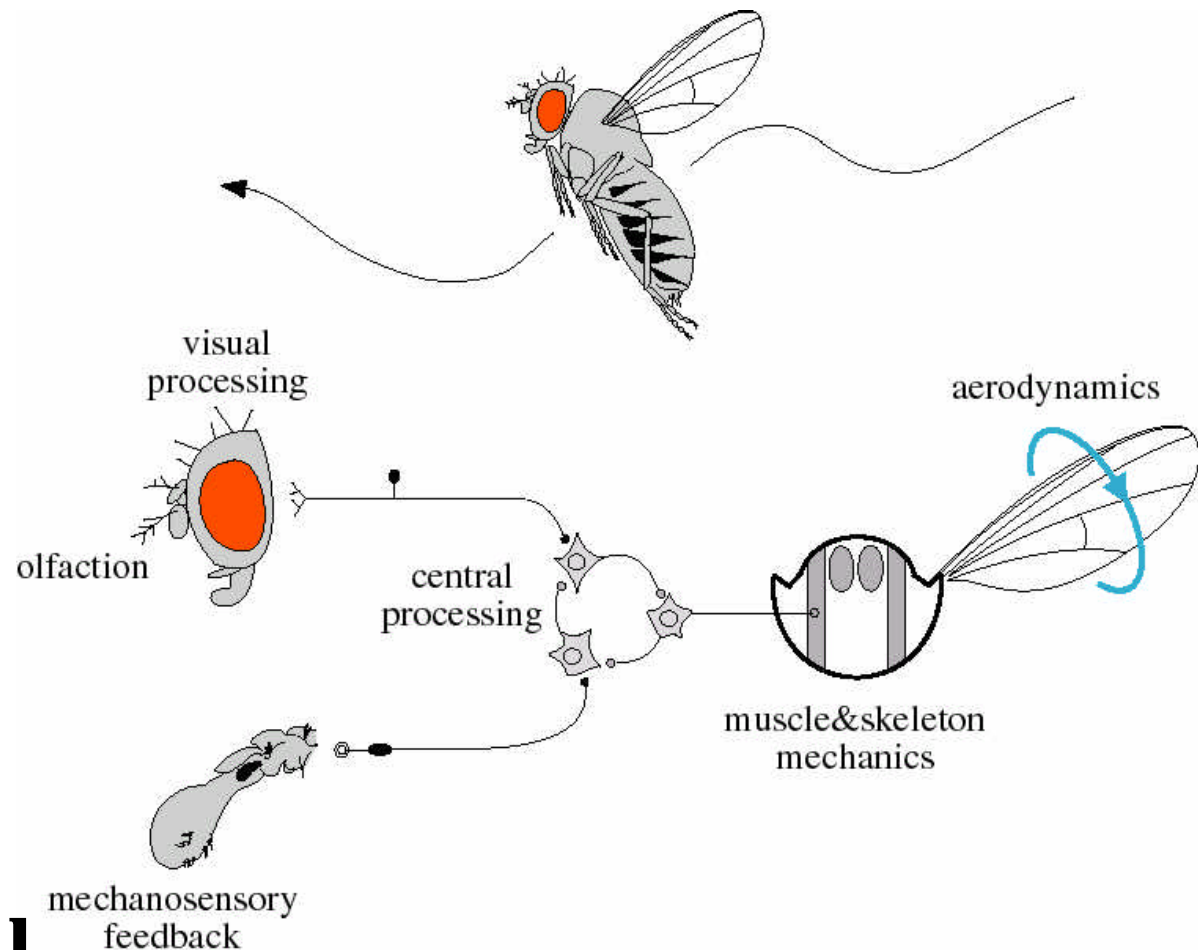
Multimodal Sensory Feedback

Lauder *Harvard*

Design and Evolution

Three dimensional force measurements in free swimming fish.

Single fin forces at 0.5 Ls^{-1}

1.6 mN

6.8 mN

5.5 mN

Integration of Muscles in Free Movement

Biewener *CFS Harvard*   Energy Management

Power Output

Force Economy & Elastic Energy Savings

Avian pectoralis muscle

Kangaroo/wallaby gastrocnemius & plantaris muscles

Engineering Perspective

Koditschek
U Michigan

Biologically Inspired Dynamic Robot

Design

Energy Management

QuickTime™ and a
decompressor
are needed to see this picture.

Bandwidth

"Rhex" **Buehler & Koditschek**